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(54) Steam trap

(57) A steam trap has a valve seat (10), a closure part (9) co-operating therewith and an associated control device (8). Downstream of the valve seat (10) is provided a second valve seat (12), as well as a second closure part (13). A control member (14, 16) influenced by the inlet side pressure is provided for the closure part (13). The latter is also under the action of an opening force of a given magnitude which force may be provided by a spring (18) or by a bellows (17) *per se*. The steam trap can be used under a high operating pressure and is resistant to wear, whilst only a relatively small constructional volume is required for the control device (8). The control device (8) may be a float or a stack of bimetallic discs (Figures 2, 4).

Fig. 1

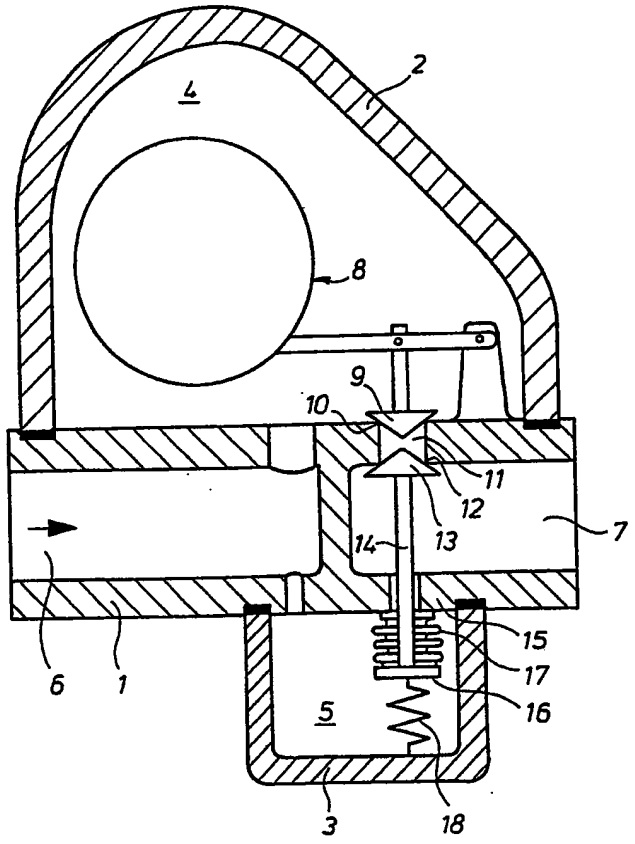

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Fig. 1

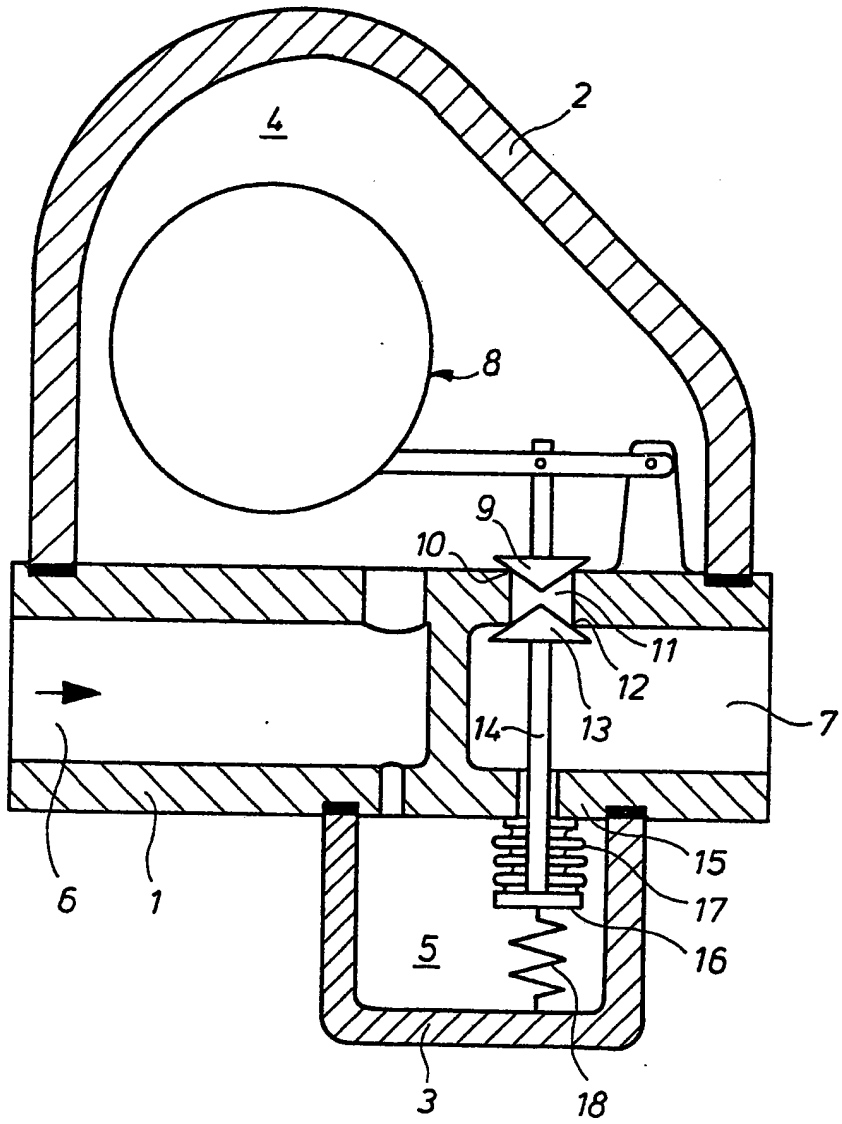

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Fig. 2

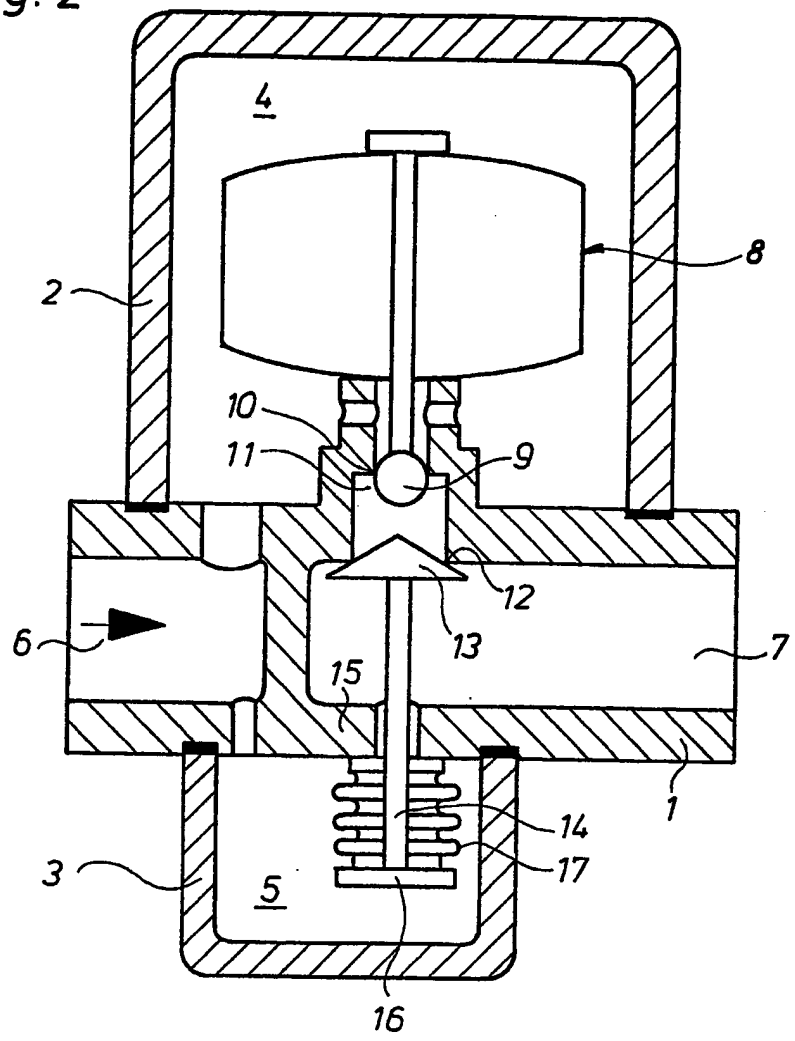

Fig. 3

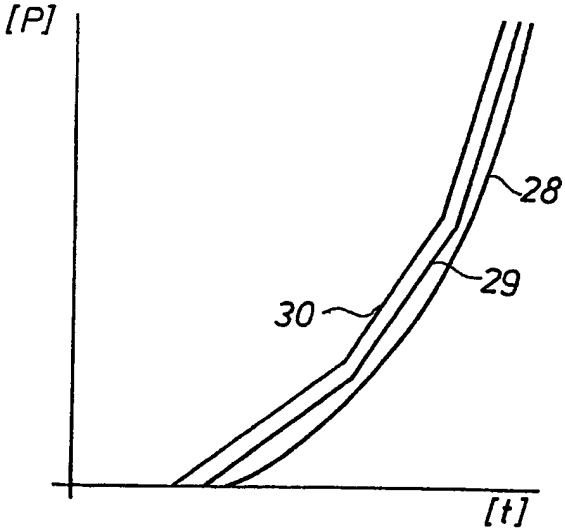

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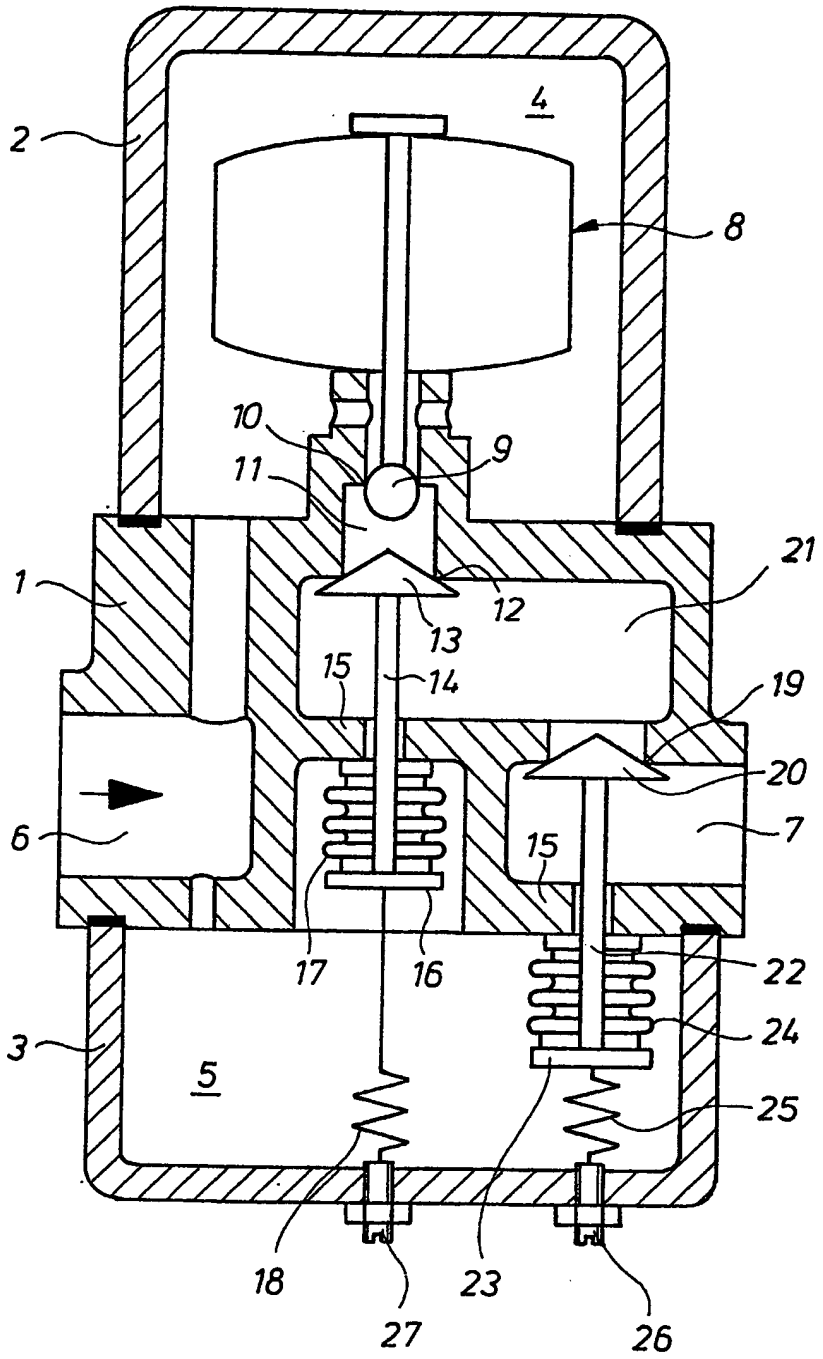
Fig. 4



SPECIFICATION

Steam trap

This invention relates to steam traps of the type having a valve seat, a closure part co-operating therewith and a control device operating the closure part.

The preferred control devices used in steam traps are float drives or thermal drives, e.g. bimetallic elements, expansion capsules containing an expansion medium and the like. In the case of installations with high operating pressures, there are relatively small condensate quantities at the drainage points at the prevailing operating pressure. These quantities are generally only a few litres per hour. However, larger quantities have to be discharged on starting up, i.e. when the installation is still cold and the pressures are correspondingly low. The higher discharge capacity on starting up and the high pressure difference acting on the closure part under operating pressure have necessarily led to larger control devices on steam traps for these particular cases.

A steam trap is known (German Patent Specification No. 2848128) for draining off larger condensate quantities from low pressure installations and in this case the control device merely acts on an auxiliary closure part, whereas the associated main closure part is operated by a piston. Thus, the control device is very small. However, this construction cannot be used under high operating pressures, because the throttle gaps required for controlling the piston would be so fine that they could not be manufactured and would also be very fault prone owing to dirt.

Furthermore, a float-controlled steam trap is known (German Patent Specification No. 3215459), in which the condensate to be drained off is passed through a throttle opening on its path along the float. As soon as the steam trap opens, an additional force acting in the opening direction occurs on the float. The control device, i.e. the float, can therefore be kept relatively small compared with the maximum discharge capacity of the steam trap. However, as said additional force always only occurs after opening, a large volume control device is required for opening purposes in the case of very high pressure differences.

In another known thermally controlled steam trap (German Patent Specification No. 1261126) with a high flow rate, the closure part is largely relieved of pressure, so that the closing force to be applied by the control device and therefore the necessary constructional volume of said control device is small with respect to the maximum flow rate. The necessary adaptation of the opening and closing curve to the temperature - pressure curve of saturated steam takes place through a special design of the control device. However, this steam trap is also unsuitable for use under a high operating pressure, because the high pressure gradient occurring in the valve seat region would lead to wear on the valve seat and/or on the closure part.

The present invention aims to provide a wear-resistant steam trap usable under a high operating pressure, which can also cope with the condensate quantities occurring on starting up the installation and which has a control device with a small constructional volume.

According to the invention, there is provided a steam trap having a first valve seat, a first closure part co-operating therewith and a control device operating the first closure part, wherein a second valve seat is arranged downstream of the first valve seat, a second closure part co-operating therewith and being arranged to be acted on by a pressure-reactive control member influenced in the closing sense by the pressure prevailing from the inlet side in the steam trap, means being provided for exerting an opening force of a given size on the second closure part.

If a low pressure prevails on the inlet side in the steam trap, the second closure part is kept in the open position by the means provided for it. The full difference between the pressure prevailing on the inlet side and the outlet side in the steam trap then acts on the first closure part operated by the control device. The steam trap capacity is such that under these conditions it is able to drain off the larger condensate quantities occurring on starting up the installation. If the inlet side pressure reaches a given threshold, then the second closure part is brought into the closed position by the control member counter to the acting opening force. Then, an intermediate pressure rising with the inlet side pressure can form in the space between the first and second shutoff points, i.e. between the first closure part with valve seat and the second closure part with valve seat. Thus, on reaching a threshold of the inlet side pressure, the first closure part is under a pressure difference, which is smaller than the difference between the inlet side and outlet side pressures in the steam trap. The work to be carried out by the control unit is limited to this smaller pressure difference on the first closure part. Thus, despite a high inlet side pressure, the necessary constructional volume for the control unit remains relatively small. If there is a high pressure in the steam trap on the inlet side, the pressure difference between the inlet side and the outlet side pressure is reduced in two stages. A first part of the pressure difference is reduced at the first shutoff point and the remainder at the second. Thus, the outflow medium exerts only limited wear on the valve seats and closure parts. Therefore the steam trap according to the invention is wear-resistant.

According to a preferred embodiment of the invention, the control member has a pressurizing surface arranged in an area exposed to the inlet side pressure, said area is separated by a partition from a lower pressure area in which is located the second closure part, a lifting member traverses the partition and connects the pressurizing surface to the second closure part and a seal is provided at the passage of the lifting member through the partition.

The seal may take the form of a bellows and the bellows may be arranged to produce the necessary opening force on the second closure part as well as having a sealing function. Alternatively, the means

for producing the opening force may comprise a spring. If the spring is adjustable, it is possible to vary the threshold at which the second closure part closes. As a result of different thresholds, it is e.g. possible to use the same steam trap for widely varying pressure ranges. Hitherto, in such cases, steam traps with differently designed or dimensioned control means were required.

In the case of steam traps with a thermal control device, particularly those with bimetallic elements, it is standard practice by special design measures on the control device to adapt the opening and closing characteristic of the steam trap in polygonal manner to the temperature - pressure curve of saturated steam. The steam trap according to the invention already has a polygonal characteristic on the control device without any special design measures. The bending point between the two polygon portions occurs at the closing pressure of the second closure part. By adjusting this closing pressure, said bending point can be displaced, so that adaptation is optimized.

According to another embodiment of the invention, a third valve seat with an associated, third closure part is arranged downstream of the second valve seat, a pressure-reactive control member being provided for the third closure part and being influenced in the closing sense by the inlet side pressure and means being provided for exerting an opening pressure of such a magnitude on the third closure part that the second and third closure parts close at different levels of the inlet side pressure. This arrangement gives an opening and closing characteristic with two bending points, so that a particularly good adaptation to the temperature - pressure curve of saturated steam is possible over a very wide pressure range.

In a preferred arrangement of this latter embodiment, the control member for the third closure part has a pressurizing surface arranged in the area exposed to the inlet side pressure, said area is separated by a further partition from a further lower pressure area in which is located the third closure part, a further lifting member traverses the further partition and connects the pressurizing surface to the third closure part and a seal is provided at the passage of the further lifting member through the further partition. Again, the seal may take the form of a bellows which may be arranged to produce the necessary opening force on the third closure part as well as having a sealing function. Again, as an alternative, the opening force on the third closure part may comprise a spring which may be adjustable.

The invention will now be further described, by way of example, with reference to the drawings, in which:-

Figure 1 is a section through one embodiment of a float-controlled steam trap according to the invention having two closure parts;

Figure 2 is a section through an embodiment of a thermally controlled steam trap according to the invention having two closure parts;

Figure 3 is a graph relating to the steam trap shown in Figure 4; and

Figure 4 is a section through an embodiment of a thermally controlled steam trap according to the invention having three closure parts.

In the drawings, like parts are denoted by like reference numerals.

Reference will first be made to Figure 1 of the drawings in which the float-controlled steam trap has a trap casing, which comprises a connecting part 1 and two domes 2, 3. The connecting part 1 has an inlet passage 6, issuing into the inner areas 4, 5 respectively of the domes 2, 3, and an outlet passage 7. The inner area 4 contains a float-equipped control device 8 for a first closure part 9 closing in the flow direction. The closure part 9 co-operates with a first valve seat 10, which on the inflow side is arranged on a flow bore 11 leading from the inner area 4 to the outlet passage 7. On the outflow side, a second valve seat 12 is provided on the flow bore 11. A second closure part 13 arranged in the outlet passage 7 and closing counter to the flow direction co-operates with the valve seat 12. The closure part 13 has a lifting member 14, which traverses a partition 15 separating the outlet passage 7 and inner area 5 from one another. The lifting member 14 carries a pressurizing surface 16 in the inner area 5 and, between the surface 16 and the partition 15, a bellows 17 is provided which seals the passage of the lifting member 14 through the partition 15. An opening spring 18 is arranged to act on the lifting member 14.

The inlet side pressure prevails in the two inner areas 4, 5. If the pressure is within a given threshold value, which is e.g. the case on starting up the installation to be drained located upstream of the steam trap, the opening spring 18 maintains the second closure part 13 in the open position counter to the closing force exerted by the inlet side pressure on the pressurizing surface 16. The full difference between the inlet side and outlet side pressure acts on the first closure part 9. The control device 8 is designed in such a way that it is able to bring the first closure part 9 into the open position against said pressure difference. As at this time the pressure difference is still relatively small, the opening force to be applied and consequently the necessary constructional volume of the control device 8 are relatively small.

If the inlet side pressure rises, then the second closure part 13 is moved in the closing direction by means of pressurizing surface 16 and lifting member 14 counter to the action of the opening spring 18. If no condensate has to be drained off, on reaching the given pressure threshold, the second closure part 13 sealingly engages on the second valve seat 12. Thus, an intermediate pressure can build up in the flow bore 11, which is above the outlet side pressure in outlet passage 7. The force to be applied by the control device 8 for opening the first closure part 9 is no longer determined by the difference between the inlet side and outlet side pressure, but by the smaller difference between the inlet side pressure and the intermediate pressure in the flow bore 11.

The graduation between the inlet side pressure, intermediate pressure and outlet side pressure is also retained when draining off condensate, because

the first and second closure parts 9, 13 open proportionally to one another. The pressure of the condensate to be drained off is reduced in two stages, namely at the shutoff point 9, 10 and then at the following shutoff point 12, 13. Even if on the inlet side there is a high pressure in the steam trap, the outflowing medium exerts only limited wear on the valve seats 10, 12 and closure parts 9, 13.

As a function of the relationship between the cross-sectional surface of the opening of the second valve seat 12 and the effective size of the pressurizing surface 16, the pressure difference acting on the first closure part 9 on closing the second closure part 13 will increase slightly, remain constant or even drop on a further rise of the inlet side pressure. The maximum force to be applied by the control device 8 can therefore be limited to this pressure difference. Therefore, the necessary constructional volume of the control device 8 is much smaller than if the latter had to function against the full difference between the inlet side and outlet side pressure.

The steam trap shown in Figure 2 differs from that shown in Figure 1 in that the control device 8 has a group of superimposed bimetallic elements, only the outer contour of which is shown, instead of a float. The first closure part 9 opens in the flow direction. The bellows 17 is chosen in such a way that it applies an opening force of an adequate magnitude for the second closure part 13, there being no need for a separate opening spring.

The function of this steam trap essentially corresponds to that described with reference to Figure 1 with the following special feature. For as long as the second closure part 13 remains in the open position, with the rise in the inlet side pressure, there is a constant rise to the compressive force acting in the opening direction on the first closure part 9. The closing force produced by the bimetallic elements of the control device 8 rises in temperature-dependant manner, which leads to a certain slope of the opening and closing characteristic of the steam trap. If the second closure part 13 closes, then on a further pressure rise, the increase in the compressive force acting in the opening sense on the first closure part 9 becomes smaller or does not occur. As a result of the temperature rise always associated with an inlet side pressure increase, there is a further rise in the closing force of the control device 8. Therefore there is a change to the slope of the opening and closing characteristic, which bend down in a polygonal manner. This achieves an adaptation to the temperature - pressure curve of saturated steam.

The steam trap shown in Figure 4 differs from that shown in Figure 2 essentially in that, downstream of the second valve seat 12, a third valve seat 19 is provided with an associated third closure part 20. A connecting passage 21 containing the second closure part 13 extends between the second and third valve seats 12, 19. A second lifting member 22 with a pressurizing surface 23, bellows 24 and opening spring 25 exposed to the inlet side pressure operates the third closure part 20 closing counter to the flow direction. In addition, both opening springs 18, 25 can be adjusted by means of screws 26, 27 on the dome 3 of the steam trap.

The two opening springs 18, 25 are dimensioned and adjusted in such a way that the second and third closure parts 13, 20 each close at a different threshold of the inlet side pressure. The lower threshold value determines the maximum pressure difference acting on the first closure part 9 and therefore the constructional volume necessary for the control device 8. The opening and closing characteristic of the steam trap bends down on reaching said threshold (cf explanation concerning Figure 2). On exceeding the higher threshold, so that both closure parts 13, 20 close, there is a build up of a further intermediate pressure in the connecting passage 21, which acts as an additional force on the second closure part 13, which influences the intermediate pressure in the flow bore 11. The characteristic then bends down again. Thus, the opening and closing characteristic can be particularly well adapted over a very wide pressure range to the pressure - temperature curve of saturated steam, without requiring special design measures for the control device 8.

The aforementioned adaptation can be gathered from the graph shown in Figure 3 in which the abscissa indicates the temperature and the ordinate the pressure. The closing characteristic 29 and opening characteristic 30 of the steam trap shown in Figure 4 are shown before the temperature - pressure curve 28 of saturated steam.

This steam trap design has an even greater resistance to wear, because the reduction of high pressure takes place in three stages.

CLAIMS

1. A steam trap having a first valve seat, a first closure part co-operating therewith and a control device operating the first closure part, wherein a second valve seat is arranged downstream of the first valve seat, a second closure part co-operating therewith and being arranged to be acted on by a pressure-reactive control member influenced in the closing sense by the pressure prevailing from the inlet side in the steam trap, means being provided for exerting an opening force of a given size on the second closure part.

2. A steam trap according to claim 1, wherein the control member has a pressurizing surface arranged in an area exposed to the inlet side pressure, said area is separated by a partition from a lower pressure area in which is located the second closure part, a lifting member traverses the partition and connects the pressurizing surface to the second closure part and a seal is provided at the passage of the lifting member through the partition.

3. A steam trap according to claim 1 or claim 2, wherein a third valve seat with an associated, third closure part is arranged downstream of the second valve seat, a pressure-reactive control member being provided for the third closure part and being influenced in the closing sense by the inlet side pressure and means being provided for exerting an opening pressure of such a magnitude on the third closure part that the second and third closure parts

close at different levels of the inlet side pressure.

4. A steam trap according to claims 2 and 3, wherein the control member for the third closure part has a pressurizing surface arranged in the area exposed to the inlet side pressure, said area is separated by a further partition from a further lower pressure area in which is located the third closure part, a further lifting member traverses the further partition and connects the pressurizing surface to the third closure part and a seal is provided at the passage of the further lifting member through the further partition.

5. A steam trap according to claim 2 or claim 4, wherein the or each seal takes the form of a bellows.

6. A steam trap according to claim 5, wherein the or each bellows constitutes the means exerting an opening force on the second closure part or on both the second and third closure parts.

7. A steam trap according to any one of claims 1 to 5, wherein the means exerting an opening force on the second closure part comprises a spring.

8. A steam trap according to claim 3, wherein a spring is provided for exerting an opening force on the third closure part.

9. A steam trap according to claim 7 or claim 8, wherein the or each spring is adjustable.

10. A steam trap substantially as described herein with reference to the drawings.

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